

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant(s): Venkat Selvamanickam, et al.

Title: METALORGANIC CHEMICAL VAPOR DEPOSITION (MOCVD)  
PROCESS AND APPARATUS TO PRODUCE MULTILAYER HIGH-  
TEMPERATURE SUPERCONDUCTING (HTS) COATED TAPE

App. No.: 10/602,468 Filed: June 23, 2003

Examiner: Jennifer C. McNeil Group Art Unit: 1775

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MS AF  
Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

**DECLARATION UNDER 37 C.F.R. §1.132**

Sir, I hereby declare and state:

1. I am a joint inventor of the subject matter presently claimed in the above-identified patent application.
2. I received my doctorate degree in Materials Engineering from the University of Houston in Houston, TX.
3. I have been employed by IGC/SuperPower, Inc. since 1994, wherein I have been mainly engaged in research and development of superconducting materials, superconducting conductors, and processes for forming same.
4. I have reviewed the Office Action dated October 18, 2005, including the positions taken by the PTO with respect to several prior art references. I have also particularly reviewed the subject matter of US 5,106,828, Bhargava et al. (Bhargava). For the reasons discussed below, Bhargava fails to disclose (or suggest) all features of the claimed invention.

5. The claimed invention is drawn to a superconductive article comprising a substrate tape and a superconductive layer. The superconductive layer notably includes a plurality of individually identifiable superconductive films of the same material, the films being disposed one atop another and in direct contact with each other. As described in the present specification, the films are formed by a metalorganic chemical vapor deposition (MOCVD) process, in which metalorganic precursors are reacted with each other in a deposition chamber, the reaction product forming a superconductive material that deposits on the substrate tape. As described in the present specification, pages 23+ in connection with FIGs. 1-4b, the substrate tape is translated through an MOCVD system containing multiple compartments arranged in series, each defining a deposition zone (see Zones A-E). Each zone has associated unique control parameters as described in Tables 1-5. As the substrate translates through the MOCVD system, the substrate tape experiences multiple deposition events, each deposition event corresponding to each zone, thereby forming an identifiable, discrete superconducting film. That is, by passage of the tape through a zone, the zone forms as-deposited superconductive material in the form of a film.

Attached hereto is an SEM micrograph showing three superconductive films corresponding to YBCO1, YBCO2, and YBCO3. Analysis shows that the individual films are identifiable and are separated by each other by boundary regions corresponding to the arrows shown on the attachment.

6. In contrast, Bhargava is drawn to a solution/sol-based process flow in which the material deposited on the substrate is a sol, corresponding to an organic *precursor* of the superconductive material. In sol-based processing, given the rheology of the sol, it is necessary to form a first precursor layer or first set of layers, followed by drying (by gas flow or microwave treatment) and subsequent deposition of a second precursor layer or second set of layers. Sol deposition followed by drying is repeated until the desired thickness of a precursor superconductive layer is deposited. Upon achievement of the desired thickness, the entire layer is pyrolyzed at high temperature (700-1000°C) to convert the precursor material into a superconductor oxide material.

At no time during the process flow of Bhargava are multiple superconductive films formed on top of each other; rather, multiple superconductive *precursor* films formed. Upon

subsequent heat treatment and conversion of the precursor films, the films form a single, unitary layer having no identifiable film boundaries. That is, due to the process flow associated with sol-based processing, identifiable superconductive films are not formed. This is due to the fact that conversion of the deposited precursor layers takes place in a single heat treatment step (pyrolysis), while the MOCVD process according to embodiments of the present invention result in as-deposited superconductive films formed via multiple, discrete depositions steps corresponding to respective zones.

Attached is an SEM cross-section of a sol-based film formed by metalorganic deposition (MOD) that was formed by multiple deposition and drying process steps to build-up the layer thickness shown in the micrograph, then converted by heat treatment. The SEM cross-section is representative of the teachings of Bhargava. As shown, the superconductive layer is a unitary structure composed of a single, monolithic mass of material entirely devoid of individual films. Likewise, because the multiple precursor films of Bhargava are converted to superconductive material in a single step, Bhargava also does not have individual layers. The drying steps of Bhargava by gas flow and brief microwave treatment to remove solvent cannot form individual layers; any boundaries resulting from drying are eliminated due to heat treatment to effect conversion (pyrolysis at 700-1000°C followed by annealing at 400-500°C).

7. In summary, it is quite clear that sol-based processing having intermediate drying steps cannot result in an superconductive layer having multiple, identifiable superconductive films.

8. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like, so made, are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

April 15, 2006

Date

  
Venkat Selvamanickam

# $\text{YBCO}$ produced by MOCVD in 3 passes



Arrows show the boundaries between the 3 layers.

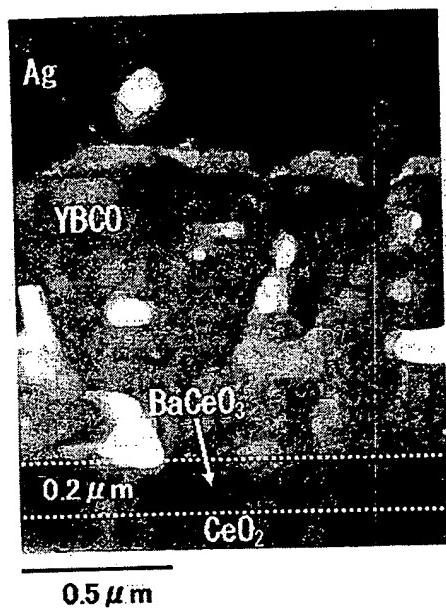


Fig. 2. TEM photograph of the cross section in the four times coated film with 1.1 μm thick.

thickness exists at the interface between the YBCO and CeO<sub>2</sub>. The reason for the degradation of  $J_c$  in the thin film could be explained by the existence of the BaCeO<sub>3</sub> layer.

#### 4. Long tape processing

When we applied the TFA process to the long tape production, the design of the gas flow system becomes a key technology. Fig. 3 shows the position dependence of the  $J_c$  in the transverse and parallel gas flow to the long direction of the tape. According to this result, a homogeneous tape can be fabricated by the transverse gas flow system. On the other hand, the  $J_c$  values in the parallel gas flow system drastically decrease from the windward to the leeward. In order to understand this tendency, we investigated the growth rate of YBCO phase. Fig. 4 shows the position dependence of the growth rate in the parallel gas flow system. From this result, the growth rate of YBCO decreased with increasing the tape length. Therefore, the YBCO reaction in the parallel gas flow

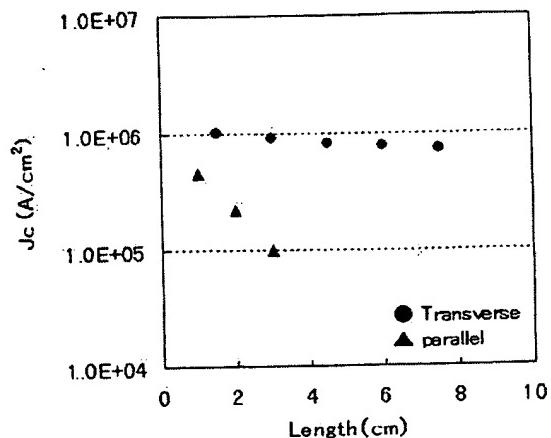


Fig. 3. Position dependence of the  $J_c$  in the transverse and parallel gas flow to the long direction of the tape.

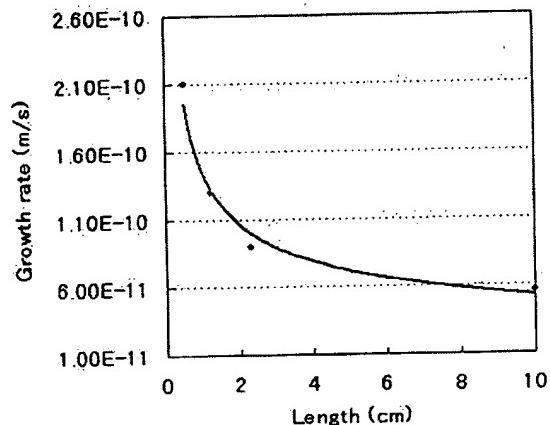


Fig. 4: Position dependence of the growth rate in the parallel gas flow system.

system may not be completed within the same annealing time. The reason for this phenomenon could be explained by the calculation of two-dimensional analysis for the mass transfer of H<sub>2</sub>O and HF gases in the gas boundary layer ahead of the surface of the precursor. The details will be published in another report [18]. Concerning the long tape processing, the above tendency should be an important problem to be solved a reasonable production rate in the continuous system. Therefore, in order to obtain a high production rate, the

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## **Superconductor Industry Person of the Year 2004 Goes to Leaders in High Temperature Superconductor Wire**

*Superconductor Week Names Alex Malozemoff and Venkat Selvamanickam to Top International Honor for Work in Applied Superconductivity*

**Tehachapi, CA, April 25, 2005** - *Superconductor Week*, the leading publication on superconductor business and technology, announced today that it has named two pioneers in the development of high temperature superconductor (HTS) wire as Superconductor Industry Person of the Year 2004. The industry's most prestigious international award in the development and commercialization of superconductors goes to **Alex Malozemoff**, Chief Technical Officer at American Superconductor Corp., and **Venkat "Selva" Selvamanickam**, Program Manager of Materials Technology at SuperPower, Inc. for their leadership, quality R&D, and advocacy.

"The most important achievements in superconductivity in 2004 were the development of long lengths of second generation (2G) HTS wire and the continued improvement of its electrical performance," commented **Mark Bitterman**, *Superconductor Week's* Executive Editor. "In naming Dr. Selvamanickam and Dr. Malozemoff jointly as Person of the Year 2004, we call particular attention to the leadership of these two extraordinary scientists in developing 2G HTS wire. Their work in this exceedingly challenging field is setting the pace in the global effort to bring superconductivity to the forefront in addressing the most pressing needs of the 21st century."



Alex Malozemoff  
Peer Endorsements for Malozemoff



Venkat "Selva" Selvamanickam  
Peer Endorsements for Selvamanickam

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A panel of nine recognized leaders in science, industry, and government in North America, Europe, and Asia selected the winners from dozens of nominations by peers around the world. *Superconductor Week* panelist **Dr. Donald Gubser**, Superintendent of the Materials Science and Technology Division at the U.S. Naval Research Laboratory and co-editor of the Journal of Superconductivity commented: "Selva and Alex are leading two of the largest industrial development programs on HTS wires in the world with the vision of establishing HTS power devices as a new industry."

"It's been my privilege to work closely with Alex for the past 13 years," said **Greg Yurek**, Chief Executive of American Superconductor. "At a time when the world was just waking up to the global industry that HTS would spawn, Alex was already forging ahead to develop the next generation of this technology. Alex's work, acknowledged by *Superconductor Week*'s award, has put 2G HTS wire technology well ahead of most expectations, and our manufacturing scale-up is now actively underway."

**Glenn Epstein**, President and CEO of Intermagnetics General, SuperPower's parent company, commented: "Since shortly after the discovery of HTS in 1986, Intermagnetics has invested substantial resources in HTS technology—beginning with the development and production of first generation wire and then moving, with Selva as the chief proponent, to 2G wire more than six years ago. As we approach the advent of commercialization of 2G HTS wire, Intermagnetics is gratified to see Selva's dedication and leadership recognized by his peers in the industry."

Dr. Selvamanickam joined Intermagnetics in 1994, where he initiated the company's 2G wire program. As Program Manager, Materials Technology at Intermagnetics' subsidiary, SuperPower, Selvamanickam manages all aspects of an \$8M/year development program with a staff of thirty scientists, engineers, and technicians. He has published 85 papers on HTS, and has more than 350 citations. In 1996 Selvamanickam received the Presidential Early Career Award from the White House—the highest honor bestowed by the U.S. on outstanding scientists and engineers beginning their independent careers.

Dr. Malozemoff, AMSC's Executive Vice President and Chief Technical Officer, joined the company in 1991. He has published 171 papers in magnetism and superconductivity, and is co-discoverer of giant flux creep in HTS, a phenomenon key to superconductor applications. Malozemoff has led AMSC's wire R&D programs, both first and second generation, along with key external collaborations such as the Wire Development Group, bringing together researchers from the National Labs and academia. He also recently was named Distinguished Lecturer for Superconductivity by the IEEE Council on Superconductivity.

**Bob Hawsey**, Manager for the Superconductivity Program at Oak Ridge National Lab, was instrumental in bringing back the Person of the Year award, which was last granted in 1997. "Recognizing the many individuals driving the global effort to commercialize superconductors is vital," said Hawsey. "*Superconductor Week*'s award calls attention to

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the importance of institutional, industrial, and governmental participation around the world in the development of superconductors. In naming Alex and Selva jointly as Person of the Year, the panel has selected two visionaries who have not only provided leadership to their organizations, but also forged successful external collaborations."

Hawsey noted that the 2G wire programs of other organizations also made important advances in 2005. "The work being done by Kazuya Ohmatsu's team at Sumitomo Electric, by Yutaka Yamada's team at ISTEC, and by Yasuhiro Iijima's team at Fujikura is exceptional. The successes of each underscore the importance of pursuing multiple technological paths in a global effort to realize the potential of 2G wire."

## Panel of 9 Leaders Selected Winners from Dozens of Nominees

Nominations for the award came from virtually every country with programs in superconductivity. The winner was determined by a panel of nine acknowledged leaders from North America, Europe, and Asia assembled by *Superconductor Week*. The selection criteria for the award included leadership, personal achievement, support from peers, and advocacy.

Describing the panel's deliberations, Bitterman commented: "The final vote was unanimous. The diligence, discernment, and strength of conviction shown by our extraordinary panelists affirms the vital importance of individual achievement in the global effort to develop advanced technology."

The panelists for *Superconductor Week's* Superconductor Industry Person of the Year 2004 were:

- **Jun Akimitsu**, Ph.D., Professor and Director of the Center for Advanced Technology, Aoyama Gakuin University, Tokyo
- **John Clarke**, Ph.D., Professor of Physics at the University of California, Berkeley, and Head of the Materials Sciences Division at Lawrence Berkeley National Lab
- **Arnaud Devred**, Ph.D., CEA/Saclay
- **Donald U. Gubser**, Ph.D., Superintendent of the Materials Science and Technology Division at the Naval Research Laboratory and co-editor of the *Journal of Superconductivity*
- **Herbert C. Freyhardt**, Ph.D., Professor at the Institut fuer Materialphysik of the University of Goettingen, and Managing Director of the Center for Applied Materials Development, Goettingen
- **Eiji Miromachi**, Ph.D., Director of the Advanced Materials Laboratory and the Superconducting Materials Center at Japan's National Institute for Materials Science (NIMS)
- **Marina Putti**, Ph.D., Professor, Physics Department of the University of Genova and INFM-LAMIA

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- **Justin Schwartz**, Ph.D., Professor of Mechanical Engineering and Leader, HTS Magnets & Materials Group of the National High Magnetic Field Laboratory at Florida State University
- **Harold Weinstock**, Ph.D., Air Force Office of Scientific Research Program Manager for Physics and Electronics and Air Force Research Laboratory Fellow at the Air Force Office of Scientific Research.

## Panelists Call Attention to YBCO Coated Conductor Achievements of 2004

While many companies are working to develop 2G wire, only candidates who received letters of nomination were considered. Bitterman commented: "In Japan, the four 2G wire programs I know of are doing very good work. In fact, two of them, ISTEC and Fujikura, have made the greatest achievements to date in terms of wire length and performance. 2G is also being developed in Europe, Korea, and soon, possibly China. Unfortunately, we did not receive nominations for the leaders of these programs. We had numerous, very excellent nominations for Alex and Selva."

**Harold Weinstock**, added: "It is entirely appropriate to have chosen Selva and Alex as co-recipients of the Superconductor Industry Person of the Year Award for 2004. Each one of these extraordinary scientists has been the acknowledged technical leader within his own organization in the development of a reel-to-reel technology for YBCO coated conductors. This technology has resulted in tens of meters of YBCO tape that can carry between 120 to 270 amps per cm width (depending on total length), and the industry is now in a position to apply these tapes to the development of major applications for power transmission, magnets, motors and generators that can operate at or near liquid nitrogen temperature. The progress achieved by both companies in 2004 is most impressive, and both companies tied for the highest grades in the 2004 U.S. Department of Energy Peer Review on Superconductivity."

"Both Alex and Selva deserve the prize for their important achievements advancing coated conductor technology in 2004," said **Marina Putti**.

"The nomination for Selva was very strong," said **John Clarke**. "No other nominee has received an award from the White House! At the same time, Alex's leadership is exemplary. To me, the decision was very clear: *Superconductor Week's* Person of the Year Award had to be given jointly to Malozemoff and Selva."

**Herbert Freyhardt** added: "I am clearly and strongly in favor of offering the Superconductor Industry Person of the Year Award to Alex and Selva."

Commenting on the nomination process, **Jun Akimitsu** said, "Although there was some spirited discussion in determining a winner, I feel we have arrived at the proper conclusion. I perfectly agree with my colleagues on the panel: *Superconductor Week's* Person of the Year Award should go to Alex and Selva."

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"Congratulations on your choices for Alex and Selva as Industry Persons of the Year," said **Paul Arendt**, Team Manager at the Superconductivity Center at Los Alamos National Lab. "I believe both individuals are key to coated conductor technology being implemented into the market place in the near future."

## Great Potential of HTS Wire is Matched by Serious Challenges

Superconductivity involves two major fields: high temperature (HTS) and low temperature (LTS) superconductors. LTS was discovered in 1911, and must be cooled to about 4K (-269°C), using liquid helium as a refrigerant. LTS electronics are being developed for use in medical, communications, computing, and advanced instrumentation applications. Already highly commercially successful, LTS wire made of Niobium Titanium (NbTi) and Niobium Tin (Nb<sub>3</sub>Sn), is used in the fabrication of high power magnets for medical, research, science, and industrial processing applications.

In 1986 of a family of ceramics that superconduct at 77K was discovered. This permits the development of devices that can be cooled using liquid nitrogen, which is both inexpensive and easy to replenish. HTS materials may provide the basis for large scale applications in electric power transmission and distribution, power quality and storage devices, motors, and generators. HTS may also offer lower cost or higher performance alternatives for some areas already using LTS materials, such as sensors or ultra high field magnet coil inserts.

"The problem with HTS ceramics, known as perovskites," explained Bitterman, "is that they are essentially powders, or at best, fine filaments. As such, they do not form easily into durable, workable materials. HTS wires were first produced by incorporating BSCCO compounds in a silver matrix, and extruding it to form a wire. This first generation (1G) wire has been used to demonstrate some of the potential uses of HTS wire. However, the commercial potential of BSCCO remains extremely limited due to its high cost to manufacture."

HTS wire under development can conduct almost 150 times the electrical current of copper wires of the same dimensions, and unlike copper, they are 100% efficient. Conventional generators and transmission lines suffer from a 7 to 11% energy loss. With the goal of making HTS wire affordable, researchers have developed various methods for coating HTS materials onto cheap metal strips, and slicing these strips to form wire. It is hoped that this second generation (2G) manufacturing technology will provide cost-effective, high performance HTS wire.

## More Endorsements of Alex Malozemoff

"Alex Malozemoff stands at the head of our field. *Superconductor Week's* Person of the Year award is fitting indeed!" said **David Larbalestier**, Director, Applied Superconductivity

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Center, L.V. Shubnikov Professor, David Grainger Professor of Superconductivity, Department of Materials Science and Engineering at the University of Wisconsin-Madison.

“Alex has been a vital member of the high temperature superconductor community since the very beginning in 1987, continued Larbalestier, “and the impact of both his scientific and technological work is without peer. Many at AMSC and elsewhere have contributed to the success of the company and the vision that HTS can come to market in an enduring way. But underpinning all is the fact that the commercialization of a highly complex materials science *must* go right! It requires deep scientific understanding, great energy, great belief, and a steadfast commitment. Alex has been in the HTS field from its very beginning, at AMSC since 1991 and he is a vital part of the technical leadership of the whole field.”

**Jacques Jouaire**, Vice President, Research and Development, Electricité de France (EDF), commented: “Having the opportunity to collaborate for several years with Alex in the frame of an AMSC/EDF partnership, I have had a good opportunity to appreciate his capabilities. I deeply value his work structuring the development roadmap of 2G HTS wire, and his methodical approach to overcoming all technical obstacles, allowing his team to reach successfully targeted milestones. Also, Alex has a special talent for explaining things and convincing his audience. His faith in the continuous progress of superconductor performance is based on an outstanding knowledge of material science and applied technology.”

**Paul Grant**, Principal, W2AGZ Technologies, who worked on the EPRI/AMSC alliance that resulted in AMSC’s commitment to metal-organic deposition (MOD) approach for fabricating 2G wire, commented: “Alex’s work builds off the great fathers of coated conductor science: Mike Cima, Amit Goyal, Parans Paranthaman, Steve Foltyn, and Paul Arendt. But without Alex’s pioneering effort leading to AMSC’s early participation in coated conductors (Alex actually coined the term), there would be no U.S. program today that has commercial promise, the national lab efforts notwithstanding. At AMSC, Alex’s main contributions have been to steer their technology program—especially coated conductors—and maintain guardianship of their extensive patent portfolio.”

**Heinz-Werner Neumueller**, Power Components & Superconductivity, Siemens AG, commented: “I have known Alex since the beginning of HTS research activities in 1987, when he published first substantial basic work on flux creep in HTS materials. During his career at AMSC he strongly pushed forward both the basic understanding of HTS materials and the practical application for devices of power engineering. His recent engagement in the field of 2G wires has paved the way for a marketable HTS technology in the future.”

Malozemoff earned a Ph.D. in Materials Science Engineering from Stanford University 1970. He earned a B.A Summa Cum Laude in Chemistry and Physics at Harvard University in 1966.

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## More Endorsements of Venkat "Selva" Selvamanickam

**Phil Pellegrino**, President of SuperPower, Inc., commented: "I have had the professional pleasure of working with Dr. Selvamanickam for more than 3 years, since I joined SuperPower as its President in 2001. In my 34 years in industry, I have never been more inspired by a professional colleague. Selva is devoted to achieving an extraordinary scientific vision. I believe he will not be deterred in leading the manufacturing scale-up and commercialization of 2G wire—an event that will enable a technological revolution in how electricity is generated, delivered, and ultimately consumed. Considering that he is still a relatively young man, I expect that Selva's name will be recorded in the annals of technological history along side of such luminaries as Faraday, Maxwell, Tesla, Edison, and Shockley."

**Carl Rosner**, President and CEO, CardioMag Imaging and 1997 Person of the Year winner, commented: "An individual like Selva working at the frontiers of HTS technology serves as an inspiration to the many young people aspiring to become scientists and engineers. Selva is an unassuming yet outstanding individual whose scientific and engineering contributions to the practical development of HTS conductors and technology have already received worldwide attention. Through broadly-based fundamental understanding of complex materials challenges and equipment innovations, he has effectively demonstrated the superiority of second generation HTS conductors over many years of prior development activities.

"I congratulate *Superconductor Week* for the most appropriate selection of Selva as 2004 Superconductor Industry of the Year," said **Dr. Paul Ching-Wu Chu**, Professor of Physics and the T.L.L. Temple Chair of Science at the University of Houston and President of Hong Kong University of Science and Technology. "Selva is one of the best material engineers and managers in the field of high temperature superconductivity, who has successfully brought together all ingredients necessary for the preparation and commercialization of HTS tapes for large current applications."

**Dr. David P. Norton**, Professor at University of Florida's Department of Materials Science and Engineering commented: "Selva has been unrelenting in his advocacy for superconducting technology and technical leadership within SuperPower. Having been involved in high Tc wire development from its inception, his scientific insight, and perseverance has proven to be a tremendous asset to the community."

**Dr. Paul N. Barnes**, Superconductivity Group Leader, Air Force Research Laboratory, commented: "Selva has done a tremendous job advancing the MOCVD coated conductor technology for long length superconducting wire, advancing from centimeter lengths to 100 meters in just a few short years. He is quite deserving of the Superconductor Industry Person of the Year Award."

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"Selva has provided the scientific innovation and technical leadership necessary to accelerate the commercialization of HTS tapes," said **Dr. Dean Peterson**, Center Leader, Superconductivity Technology Center, Los Alamos National Lab. "All superconductor developers have benefited from his outstanding dedication and effective management skills."

Selvamanickam earned a Ph.D. degree in Materials Engineering and an M.S. degree in Mechanical Engineering from the University of Houston. His B.E. degree with Honors was earned at the Regional Engineering College in Tiruchi, India in 1986.

## About The Superconductor Industry Person of the Year

The Superconductor Industry Person of the Year is the only international award recognizing individual achievement in the global effort to develop and commercialize both high and low temperature superconductors. Mark Bitterman, *Superconductor Week*'s Executive Editor, will present the award's official plaque to the winners at the CEC/ICMC 2005 conference in Keystone Colorado during the Awards luncheon on Wednesday 31 August.

*Superconductor Week* last named a Person of the Year in 1997, when Allan Hoffman was the recipient. Prior recipients include Greg Yurek, Robert Haddon, Carl Rosner, and Sungho Jin. Going forward, *Superconductor Week* will institute the award on an annual basis. A call for nominations for the 2005 Person of the Year will be sent out on September 1, 2005. To be included in the call for nominations, send your email address to: [scipoy@superconductorweek.com](mailto:scipoy@superconductorweek.com).

## About Superconductor Week

Founded in 1987, *Superconductor Week* is the leading newsletter covering the technology and business of superconductivity. Subscribers include executives, technologists, officials, and investors in every country developing advanced technologies. Published 24 times a year, interviews, analysis, and updates provide strategic insight into the development and commercialization of superconductors in medical, electric power, communications, military, transportation, industrial processing, basic science, and other markets. For more information, visit [www.superconductorweek.com](http://www.superconductorweek.com)

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**SuperPower Achieves Top Ranking From DOE Peer Review Panel For  
2nd-Generation HTS Wire Program**

**• *Panel Cites 'World-Class Project' And 'Focused, Goal-Oriented Effort'***

**Schenectady, N.Y., October 2, 2003**—SuperPower Inc., a wholly owned subsidiary of Intermagnetics General Corporation, has been recognized in a federally sanctioned review as having the top ranked program over the past year for advancing second-generation high-temperature superconducting (HTS) wire technology. SuperPower was one of 14 industry and national laboratory participants in the U.S. Department of Energy's 2003 peer review event. HTS wire is being developed as a higher capacity replacement for copper wire currently being used in devices such as transmission and distribution cables, transformers, motors and generators. HTS wires have as much as 100 times the current carrying capacity as ordinary conductors.

Philip Pellegrino, president of SuperPower, stated: "It was a special honor to be so distinguished in view of the intense competition and deserving programs at this year's peer review. The Department of Energy is the major sponsor of HTS programs in this country and, as such, all participants in the program showcase their very best at the annual review." Pellegrino added, "The strength of our second-generation HTS wire program is that we have a clear roadmap to full-fledged production and we are addressing not only present-day issues but also those that we anticipate to be critical along the pathway to production"

The progress of SuperPower and other participants in the peer review process was ranked by an independent committee based on performance against previously stated goals, goals for the next year and the level of research integration with the national laboratory (or industry) partners. SuperPower reported that it met or exceeded all goals it had established a year ago at the 2002 peer review. In the 2002 peer review, SuperPower reported a second-generation conductor performance level of 90 A-m over 1 m lengths. In the 2003 peer review, this performance level was increased by more than an order of magnitude to almost 2000 A-m over 18 m lengths. More importantly, these performance levels were demonstrated using a superconductor deposition process that offers the advantage of the highest tape throughput among all processes that are being developed by companies worldwide at relatively low capital cost.

Tape throughput obtainable in the HTS manufacturing process is expected to have the most impact on the cost of second-generation HTS conductor. Unlike first-generation HTS conductor,

where there is only one known manufacturing technique, numerous manufacturing techniques are possible with second-generation conductor. SuperPower has chosen an HTS manufacturing process that is at least 15 times faster than processes used by other companies.

In awarding SuperPower the top ranking, the peer review committee noted that the second-generation HTS wire program at SuperPower is a “world-class project” and a “focused, goal-oriented effort” with a “strong innovative streak fostered by management, leading to strong team effort achieving and exceeding stated (ambitious!) goals.”

The peer review panel commended SuperPower not only for the high performance levels achieved over long tape lengths, but for an overall effort that addressed broader issues in scaling up second-generation HTS wire to commercial production. The panel commented that SuperPower’s “risk mitigation through planning/ingenuity enabled tremendous strides in throughput, performance and practical conductor development.” SuperPower disclosed major advances in the development of a practical, robust second-generation conductor at the 2003 peer review.

SuperPower reported development of a new process for application of a copper stabilizer overlayer and demonstrated that with such an overlayer, the second-generation HTS tapes can be overloaded to three times critical current without loss in performance. SuperPower also reported advances with slitting technology, where tapes are slit into numerous narrow tapes more appropriate for device fabrication. A significant development announced at the peer review was that SuperPower’s tapes could retain twice as much current in a magnetic field of 1 Tesla as compared to other state-of-the-art second generation HTS tapes. Tape performance in a magnetic field is important to all HTS devices, especially generators and motors.

SuperPower scored high on research integration with its national laboratory partners, particularly, Los Alamos National Laboratory. SuperPower and Los Alamos, which amply supported SuperPower’s accomplishments this year, recently concluded a three-year cooperative research and development agreement and signed a follow-on two-year agreement.

One example of a successful integration of LANL’s technology at SuperPower’s pilot manufacturing facilities is the electropolishing process for producing very smooth, clean substrates. This technology was first disclosed by LANL at the 2002 peer review. Within a year of its announcement, SuperPower’s personnel were trained in the process technology at LANL, following which SuperPower designed, procured, and installed a pre-production scale electropolishing facility in-house. Furthermore, SuperPower demonstrated 100 m long highly polished substrates with a quality similar to that reported by LANL. In the process, a 6-fold increase in tape throughput was demonstrated in the polishing of high quality substrates.

The peer review panel also commended SuperPower for “establishing QC for long length production and thoroughly ‘sleuthing’ poor performance to find the cause”. They added that SuperPower had developed “great investigative procedures to determine problems and follow up to correct processing. Reel-to-reel diagnostics and controls are a strength.” A major advancement by SuperPower in the area of QC for long-length second-generation HTS tape production was a breakthrough design for a quality control tool for texture measurement. This QC tool is valuable not only in SuperPower’s manufacturing process, but also for any manufacturing process used by any company that is scaling up second-generation HTS wire. A QC tool similar to that developed by SuperPower has prominently featured as an important necessity in second-generation HTS wire development roadmap issued by DOE.

SuperPower expects to demonstrate the performance of its HTS wire in an underground cable demonstration project currently underway in Albany, New York, where a 30 meter section of first generation cable will be replaced with a cable utilizing 2<sup>nd</sup> generation HTS wire. This is expected to be the world's first in-grid demonstration of a device powered by 2<sup>nd</sup> generation HTS wire.

SuperPower, Inc. is a wholly-owned subsidiary of Intermagnetics General Corporation (Latham, NY) focusing on Energy Technology. Intermagnetics, drawing on the financial strength, operational excellence and technical leadership in its core businesses of Magnetic Resonance Imaging and Instrumentation has become a prominent participant in superconducting applications for Energy Technology. The company has a more than 30-year history as a successful developer, manufacturer and marketer of superconducting materials, radio-frequency coils, magnets and devices utilizing low- and high-temperature superconductors and related cryogenic equipment. Intermagnetics derives current revenues primarily from applications within magnetic resonance imaging for medical diagnostics and cryogenic applications for vacuum and related processes. The company is at the forefront in the development of high-temperature superconductor-based applications that would provide increased capacity and reliability for transmission and distribution of electric power. Through its own research and development programs and in conjunction with industry and other partners, Intermagnetics is committed to further commercialization of applied superconductivity and cryogenic systems for a broad range of applications.

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*Safe Harbor Statement: The statements contained in this press release that are not historical fact are "forward-looking statements" which involve various important assumptions, risks, uncertainties and other factors. These include, without limitation, the assumptions, risks, and uncertainties set forth here as well as in the company's Annual Report on Form 10-K, including but not limited to, the company's ability to: (1) attract and maintain strategic partners for its HTS initiatives; (2) invest sufficient resources and receive additional external funding to continue its development efforts; (3) attract and retain the personnel necessary to achieve its objectives; (4) attain commercial acceptance for and adoption of its products and technology; (5) meet the cost-benefit ratio that will be critical to making HTS technology commercially viable; and (6) avoid the potential adverse impact on the company of emerging patents in the highly competitive energy technology field. Except for the company's continuing obligation to disclose material information under federal securities law, the company is not obligated to update its forward-looking statements even though situations may change in the future. The company qualifies all of its forward-looking statements by these cautionary statements.*



FOR IMMEDIATE RELEASE  
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## INTERMAGNETICS RATED NO. 1 FOR 2ND-GENERATION HTS WIRE PROGRAM

- *SuperPower Achieves Top Ranking From DOE Peer Review Panel*
- *Panel Cites 'World-Class Project' And 'Focused, Goal-Oriented Effort'*

**LATHAM, N.Y., October 2, 2003**—Intermagnetics General Corporation (NASDAQ: IMGC) subsidiary Superpower, Inc. has received top ranking in a federally sanctioned review for advancing second-generation high-temperature superconducting (HTS) wire technology. SuperPower was one of 14 industry and national laboratory participants in the U.S. Department of Energy's 2003 annual peer review event.

Receiving the top ranking is unusual for a private-sector company. In more than 10 years of peer reviews, that ranking has typically gone to national laboratories since much of the basic underlying research occurs at that level. Technology then has been transferred to industry to be scaled up. In fact, SuperPower finished second last year to its primary technology partner Los Alamos National Laboratory. SuperPower and Los Alamos, which supported SuperPower's accomplishments this year, recently concluded a three-year cooperative research and development agreement and signed a follow-on two-year agreement.

The progress of SuperPower and other participants in the peer review process was ranked by an independent committee based on performance against previously stated goals, goals for the next year and the level of research integration with the national laboratory (or industry) partners.

The peer review committee noted that the second-generation HTS technology program at SuperPower is a "world-class project" and a "focused, goal-oriented effort" with a "strong innovative streak fostered by management, leading to strong team effort achieving and exceeding stated (ambitious!) goals."

Glenn H. Epstein, chairman and CEO of Intermagnetics, said: "This latest peer ranking reinforces our confidence in the course we are taking in developing the next generation of HTS cables and devices. The second-generation HTS wire program is important because it is expected to be the enabling technology for almost all HTS devices that are being developed for electric power applications. We are gratified to learn that our investment in this technology has led to significant advancements at SuperPower."

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Philip J. Pellegrino, president of SuperPower, added: "It was a special honor to be so distinguished in view of the intense competition and deserving programs at this year's peer review. The Department of Energy is the major sponsor of HTS programs in this country and, as such, all participants in the program showcase their very best at the annual review."

James Daley, superconductivity manager in DOE's Office of Electric Transmission and Distribution, said: "SuperPower has focused their efforts on a scalable manufacturing process in the past year and has made remarkable progress - as this year's reviewers concluded. Second-generation HTS wire technology has been a program priority for eight years because of the potential to dramatically lower cost. These results confirm that excellent performance can be achieved using inherently low cost processes - a necessary and important achievement. Intermagnetics and SuperPower deserve this recognition."

**SuperPower, Inc.**, ([www.igc-superpower.com](http://www.igc-superpower.com)) a wholly owned subsidiary of Intermagnetics General Corporation, uses core capabilities in materials, cryogenics and magnetics to develop state-of-the-art second-generation HTS wire, and electric power components such as underground transmission and distribution cables, transformers, and fault current limiters.

**Intermagnetics** ([www.igc.com](http://www.igc.com)), drawing on the financial strength, operational excellence and technical leadership in its core businesses of **Magnetic Resonance Imaging and Instrumentation** has become a prominent participant in superconducting applications for **Energy Technology**. The company has a more than 30-year history as a successful developer, manufacturer and marketer of superconducting materials, radio-frequency coils, magnets and devices utilizing low- and high-temperature superconductors and related cryogenic equipment. Intermagnetics derives current revenues primarily from applications within magnetic resonance imaging for medical diagnostics and cryogenic applications for vacuum and related processes. The company is at the forefront in the development of high-temperature superconductor-based applications that would provide increased capacity and reliability for transmission and distribution of electric power. Through its own research and development programs and in conjunction with industry and other partners, Intermagnetics is committed to further commercialization of applied superconductivity and cryogenic systems for a broad range of applications.

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## **Intermagnetics' SuperPower Subsidiary Reports Repeat of No. 1 Ranking for 2<sup>nd</sup> Generation HTS Wire Program at 2004 DOE Peer Review.**

**Schenectady, NY, September 22, 2004** - As reported in the Intermagnetics General Corporation Press Release dated August 4, 2004, SuperPower presented the results of its latest 12-month effort to scale-up to commercial production of 2<sup>nd</sup> generation HTS wire at the July 2004 DOE Annual Peer Review. These results enabled SuperPower to retain the No. 1 ranking among organizations involved in developing 2<sup>nd</sup> generation HTS technology, as initially earned during the 2003 DOE Annual Peer Review (see Intermagnetics Press Release dated October 2, 2003). This year, two organizations obtained the same top score, resulting in a tie for first place.

SuperPower was able to report

- World Record Achievement of 7,000 Amp-Meters in 100-Meter 2G HTS wire.
- Enhanced facilities to enable routine production of 100 meter lengths of 2G wire.
- Demonstration of critical currents of 380 amperes in a short sample, and up to 250 amperes in 1 meter lengths of 2G wire.
- Fabrication of four electrical coils using about 25 meters of 2G HTS wire, delivered to Rockwell Automation for integration into a small demonstration HTS generator. This resulted in the world's first demonstration of the use of 2G wire in a rotating machine.
- Transition of high-throughput buffer layer technology developed at LANL to SuperPower's pilot production facilities and fabrication of several 100 ampere, 2 meter 2G wires using this high-throughput processing technology.
- Demonstration of linear speed greater than 10 meters/hour in every processing step to produce 2G wire. High throughput is essential for commercial viability.
- Demonstration of industry-leading 2G wire performance in high magnetic fields, under mechanical strain and with the addition of electrical stabilization techniques.
- Development of slitting technology to produce 4 mm wide 2G wire with at least 100 amperes/cm performance in lengths of several meters.
- Development of a patent-pending photolithography process, demonstrating up to 100 times lower AC losses.
- First shipment of 2G HTS wire to Sumitomo Electric Industries for the Albany HTS Cable Project. Sixty meters of SuperPower's wire were fabricated into a one meter HTS cable for testing, the world's first use of 2G wire in a practical 4 mm width in an HTS device. The measured ac losses were up to 20 times lower than previously demonstrated. Reduction in ac losses is an important factor in minimizing the associated cryogenic refrigeration requirements for HTS cables.
- Receipt of R&D 100 Award for a tabletop X-Ray Diffraction system, developed in conjunction with X-Ray Optical Systems (East Greenbush, NY) and the New York State Research and Development Authority (NYSERDA), that will measure the uniformity of both the buffer layer and the superconductor layer of the 2G HTS wire.

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SuperPower's focus on commercialization is evident through its effort to produce a high quality and practical end-product. The 4 mm wire width enables the HTS wire to be wound around small 16 mm diameter cable formers, while exhibiting superior bend and tensile strength, as well as power handling capability. High throughput processing methods continue to be refined with the goal of achieving a reasonable-cost replacement for copper wire. Peer Reviewers made positive note of the emphasis SuperPower continues to place on automation and monitoring of the processes.

Overall, SuperPower's performance and results were rated as "world-class" by the Peer Reviewers. SuperPower scientists and engineers were commended for "maintaining good focus" on the program goals, resulting in "a remarkable year of achievements." Reviewers commented on the strong teamwork in place at SuperPower, enabling remarkable achievements toward integrating a variety of new approaches quickly and successfully in spite of a variety of challenges, not the least of which is related to budgetary constraints at the Department of Energy and its National Labs. On the latter point, the Peer Reviewers commented that the program needs more funding support from DOE in fiscal year 2005.

In particular, it was noted that the sharing of expertise with the various DOE National Laboratories, including Los Alamos, Oak Ridge, Argonne and Brookhaven, continues to be top notch, as does SuperPower's collaboration with other research entities including the Air Force Research Lab (AFRL), the National Institute of Standards and Technology (NIST) several universities, and SuperPower's project partners. In large part, these collaborations are credited with accelerating the technology progress and removing barriers to success.

Peer Reviewers continue to look for progress in SuperPower's unique MOCVD approach to applying the superconducting material and applaud the excellent progress made to date.

Glenn H. Epstein, chairman and chief executive officer of Intermagnetics said, "SuperPower continues to demonstrate its position as a global leader in 2G wire performance. We are gratified to retain our No. 1 ranking among our peers in this effort and maintain our determination to become commercially viable in 2005, and in full scale production by 2006."

Philip J. Pellegrino, president of SuperPower, added, "I continue to be extremely proud of the SuperPower development team as we continue to meet and beat each and every milestone set. The positive and constructive feedback received from this latest DOE Peer Review serves to confirm the path we have chosen to achieve commercialization of our 2G HTS technology."

For access to the various presentations included in the 2004 Annual DOE Peer Review, please visit the following DOE web page:

<http://www.energetics.com/supercon04.html>

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